SEAFRAME

Fall 2005 • Volume 1 • Issue 2 *Ships & Ship Systems Quarterly Publication*

SEA JET

A Testbed for Technology

ADVANCED ELECTRIC SHIP DEMONSTRATOR

Report Documentation Page

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Supporting Customers through Collaboration and Teaming

Ships & Ship Systems NotePAD

By Charles (Randy) Reeves

One of the primary responsibilities of the Product Area Directors (PADs) is to reach across geographical and organizational boundaries and find innovative ways to introduce synergy and collaboration, efficiency, and effectiveness into Warfare Center work. This is crucial to bringing the best capabilities to bear for the customer.

Within the Ships and Ship Systems (S^3) Product Area (PA), we are collaborating in multiple areas. Examples of teaming include the S^3, Littoral Warfare Systems (LWS), and Undersea Warfare Weapon and Vehicle Systems (USW W&V) PA agreement for Warfare Center support of unmanned underwater and surface vehicles. Another agreement for support of Navy Fuel Cell development is between the S^3 and USW W&V PAs and involves three Warfare Center sites—Crane, IN; Philadelphia, PA; and Newport, RI.

The first ship type agreement is for support of the Littoral Combat Ship. The agreement is for a Customer Advocate Concept of Operations (CONOPS) that involves six PAs and crosses three program executive offices (PEO Ships, PEO Littoral Mine Warfare, and PEO Integrated Warfare Systems). The CONOPS provides a framework to integrate and coordinate the customer advocates across the three PEOs to provide timely and efficient access to the full spectrum of technical expertise in the integrated Warfare Center.

Other teaming initiatives focus on creating Communities of Interest (CoI), in which the technical communities from across the Warfare Center work as a group, understanding the capabilities that exist across the various divisions. A significant CoI that the S^3 PA initiated is for hydrodynamics, which involves work done in West Bethesda, MD; Newport, RI; and Panama City, FL. Additionally, we've formulated customer teams, which work together to look at a single customer. Eight PADs, including S^3, and seven warfare center sites are teamed to determine the best way to provide support for the Special Operations Command.

The S^3 PA is also teaming with the Undersea Warfare Command and Control Systems (USW C&C) PA on submarine periscopes, where we provide the expertise on the hull and mechanical side of periscopes, and they provide expertise on the actual sensors to provide a product and service to the fleet.

The S^3 PA also collaborates with industry through Work for Private Party agreements and with Technical Warrant holders through Engineering Agent Agreements. We team across services, like the S^3 memorandum of agreement with the U.S. Army for support of small watercraft. An article in our Customer Advocacy section on page 6 demonstrates our teaming with the U.S. Coast Guard, as well.

Through all of these efforts, the S^3 PA is actively facilitating collaboration and synergy across the Warfare Center. The Customer Advocate concept was an outgrowth of the need for the PAs to collaborate, with advocates from multiple divisions or sites working with a single PA to ensure the right work, in the right place, at the right time. These collaborations serve to provide the customers with our best capability, which results in the best service or products.

CRReeves

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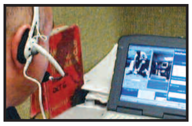
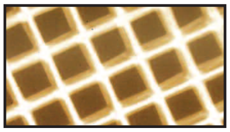
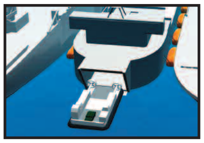
On the Cover: The Advanced Electric Ship Demonstrator will support testing of new all-electric propulsion systems being considered by the Navy for integration into new ship designs. Future tests involve a waterjet propulsion system and a podded propulsor without propeller shafting.
See story on page 12.
Images provided by John Williams, ONR.
Cover design by Gloria Patterson.

TABLE OF CONTENTS







S3 BUSINESS

Work Assignment

Ensuring the Right Work Goes to the Right Place

By Peter Montana and Leslie Spaulding

The NAVSEA Warfare Centers are a vast corporation with diverse capabilities supporting the Navy and the Nation's national defense policy. These capabilities cross the spectrum from components to systems to platforms to forces. With this breadth and depth of capabilities, ensuring the work required by customers is done by the right people at the right places presents a challenge to the senior management of the Warfare Centers. To overcome this challenge and help streamline the organization, NAVSEA established the product area directors (PADs) as the national experts in their assigned areas to provide a product focus across the corporation and to provide the stewardship for the capabilities needed to produce those products. A critical component of the product area directors' responsibilities is work assignment—ensuring the right work goes to the right place.

The work assignment process answers a series of questions:

- Is the work appropriate for the Warfare Centers?
- If so, under which product area?
- Should it be done by the government or the private sector?
- Does the nature of the work mandate government performance? Why?
- Who is the best athlete to perform the work?
- Who provides the best value to the government?

The PADs are responsible for answering all these questions and more before work may be accepted and performed for customers.

One of the tools used by the PADs to execute work assignment responsibilities is the Work Assignment Website (WAW). It captures capability descriptions, deliverables, and decision rationale for why work is accepted and which warfare center sites are responsible for performance of the work, whether the work is performed within the government or in the private sector. The WAW also helps the PADs manage workload to ensure that capabilities (personnel, expertise, and facilities) can be sustained for the future without building capacity for performance beyond that needed for government roles.

To promote efficiency, emphasis is placed on teaming across the Warfare Centers in areas where there is shared expertise. The PADs also focus on utilizing existing capability for emerging requirements and reducing or eliminating redundant capabilities or excess capacity.

Through the work assignment process, each PAD certifies the work requested by the customer is being done by the right organization within the Warfare Centers. The WAW helps the PAD realign work, remove redundancies, and capitalize on areas of expertise, without regard to geographic location. WAW is being linked to other business tools within the Warfare Centers' corporate database to aid in workforce planning, technical health assessment, technical authority management and execution, and facility management—helping the Warfare Centers effectively manage resources.

Since coming online in April 2004, the WAW has provided NAVSEA with greater insight based on more thorough data with instant transparency of the Warfare Center Divisions' activities. It is helping NAVSEA, the Warfare Centers, and the respective product area directors satisfy the requirements of their customers in an effective and efficient manner.

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CUSTOMER ADVOCACY

CUSTOMER ADVOCATES for SHIPS

Supporting the Fleet from Acquisition to Modernization

By Leslie Spaulding

Customer advocates serve as functional agents of the product area directors (PADs). Their role is to interface with customers to develop a unified customer support approach, bringing together efficient and effective combinations of technical capabilities that span multiple divisions. The Ships Customer Advocates within the Ships and Ship Systems (S^3) Product Area (PA) are working with the Program Executive Office (PEO) Ships to ensure the best fleet for today and tomorrow.

PEO Ships manages all Navy surface ships. The lead Ships Customer Advocate, Richard Stutchfield, and his team work with the PEO Ships' program managers on all areas supported by the S^3 PA. The advocates coordinate customer support throughout the Warfare Centers to ensure the right work is performed at the right place at the right time.

CAs FOR SHIPS (Continued on page 4)

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USS Arleigh Burke
DDG-51 Class
–U.S. Navy Photo.

CAs FOR SHIPS (Continued from page 3)

In the area of ship acquisition, the S^3 ships customer advocates are supporting a variety of programs. There are more than 10 different acquisition programs underway—with many undergoing evolutions of one kind or another. Although awaiting future direction through the Quarterly Defense Review early next year, the ships customer advocates are working to ensure customer needs are met according to current requirements.

In some cases, this requires quick adaptation on the part of the customer, the advocate, and the scientists and engineers. For example, support of the Maritime Prepositioning Force (Future) recently changed from looking at new ship designs to focusing on building the force from existing/modified ship designs. In another acquisition program, work continues on supporting the many new technologies linked to the DD(X) Class, with the knowledge that this work will have applicability to future classes of surface combatants. Another example in fine tuning acquisition support involves the LPD 17, which is currently undergoing trials. This program presented a challenge as it is the first Navy ship constructed under Acquisition Reform—which meant a whole new way of doing business.

Within the S^3 Product Area, the Littoral Combat Ship (LCS) provides the most opportunity for teaming across the various divisions within the Warfare Centers. The LCS is divided into two major areas, the seaframe and the mission package. The seaframe is designed to provide "core" self-defense and mobility capabilities, which will allow the ship to reach speed, range, and inherent capabilities goals. The mission packages are designed to provide focused capabilities, such as anti-submarine warfare. These packages are being developed as modular, reconfigurable units that can be installed into the seaframe as needed to conduct focused missions. The development and fielding of the seaframe and mission packages involve numerous product areas, which communicate quickly and openly to ensure the effective integration. Integration and reconfiguration are facilitated by the Interface Control Document, which defines standard interfaces (space, electric, power, cooling, command and control, communications, human systems integration, etc.) between the seaframe to mission packages. This program is moving at unprecedented speed—going from concept to deployment in a very short period.

The S^3 in-service engineering work is also evolving with the customer. With the major reorganization of the waterfront in the formulation of regional maintenance centers, the Warfare Centers have become less involved in daily maintenance issues and more involved in modernization. With fewer new ships being built, the Navy has put increased emphasis on the development of ship class mid-life modernization/sustainability programs.

In production since the late 1980s, the DDG Class is providing a unique opportunity in the area of modernization. The program is now producing its 50th ship in a class of 62. The DDG 51 was commissioned in 1991—the final ship of that class will be commissioned in 2012. A lot of engineering work goes into backfitting a ship to modernize its technology—an expensive endeavor that is necessary to extend the useful life of a ship. Because this class is hitting mid-life while still under construction, the Navy is designing the final two ships with modernization of the older ships in mind—thus absorbing in new construction the costs of modernization.

"The linkage between what we do in the S^3 Product Area and the work being done in the other product areas is critical to making these mid-life programs a success," said Stutchfield. "How an upgrade of one system affects another is crucial in making decisions in both modernization and new acquisition. All of the product areas must work together to develop integrated products."

Collage of Navy Ships: ***USS Wasp*** (LHD 1), ***USS Tarawa*** (LHA 1), ***USS Blue Ridge*** (LCC 19), LCAC, DDX, LCS, and ***USS San Antonio*** (LPD 17).
U.S. Navy Photos and Renderings.

Customer Advocacy

Navy/Coast Guard Teaming

Extending the Life of an Aging Fleet

Robert Peach, Kevin Clear, Robert Young, and Richard Grassia review their findings from ultrasonic thickness inspection of the ship's pilot house.
Photo provided by Richard Grassia (NSWC).

By William Moss, Richard Grassia, William Goins, and Leslie Spaulding

The present U.S. Coast Guard fleet of high- and medium-endurance cutters is older than 37 of the world's 39 naval fleets. With 14 federally mandated missions, the Coast Guard is challenged by operating and maintenance costs. These missions span critical areas such as homeland security, law enforcement, search and rescue, environmental protection, and defense operations. One of the Coast Guard's greatest challenges is to operate efficiently and cooperatively with U.S. Navy forces.

This leads to the need for close collaboration between the Navy and Coast Guard. Engineers supporting the Ships and Ship Systems (S^3) Product Area have been working under a memorandum of agreement with the Coast Guard since 2004. Under this agreement, personnel support the legacy cutters as well as the Integrated Deepwater System (IDS) acquisition program. IDS is the cornerstone of the Coast Guard's approach to addressing problems associated with aging assets. It includes the capabilities-based replacement and/or modernization of all major Coast Guard cutters, as well as aircraft, communications, sensors, and logistics infrastructure. Like the Navy, the Coast Guard is interested in reducing manning and operational costs, while increasing operational availability.

Personnel supporting the S^3 Product Area have worked with the Coast Guard for many years, assisting with hull, mechanical, and electrical design and in-service engineering, as well as with smaller acquisition programs. In fact, the USCG recently recognized 15 support personnel from the S^3 Product Area for their expertise and value as Developmental Test and Evaluation Team members on the Response Boat–Medium (RB-M) acquisition program. This team received the Coast Guard Meritorious Team Commendation from USCG Rear Admiral D.G. Gabel, Assistant Commandant for Acquisition.

Close S^3 collaboration and teaming to support the Coast Guard is required. To facilitate this effort, a customer advocate for Coast Guard programs was identified. "In addition to the IDS, the Coast Guard signed a memorandum of agreement with the Littoral Combat Ship (LCS) Program Executive Officer," said William Moss the S^3 customer advocate for Coast Guard programs. "This could be an opportunity for the Navy Warfare Centers to work even more closely with the Coast Guard to mature and introduce new technologies via the 'spiral design' acquisition process. The Coast Guard is interested in identifying common technologies, systems, and processes critical to both LCS and IDS. The IDS platforms will more likely be built before LCS platforms and can become the lead platforms to proof-in the new technologies."

At right, U.S. Navy divers prepare to conduct underwater ultrasonic hull inspection aboard ***USCGC Dependable***.

Below, James Lusas inspects beneath the machinery foundation to evaluate material condition.

At bottom, William Goins, Robert Peach, and Kevin Clear conduct external ultrasonic thickness measurements of the "boot top" area from a small boat.

Photos provided by William Goins (NSWC).

An example of the support provided by engineers working in the S^3 area involves extending the life of the 27-year-old, 210-foot medium-endurance cutter ***USCGC Dependable*** (WMEC 626). These engineers conducted a survey of the piping systems, ventilation systems, underwater hull, waterline boot top, weather decks, superstructure, and all accessible internal spaces using visual inspection and ultrasonic inspection techniques. Areas designated as "wet spaces" and other corrosion prone areas of the ship were thoroughly assessed, as well as other areas identified by the Type Commander and ship's force.

The team compiled more than 7,000 ultrasonic testing data points, incorporating them into an easy-to-read spreadsheet and developing drawings on site to illustrate the piping. The result was an assessment of the entire hull structure, which included an underwater ultrasonic hull inspection conducted by U.S. Navy divers. Additionally, the main propulsion shafts, propellers, rudders, skeg, stern tubes, struts, sea chests, and bilge keel were also inspected.

All discrepancies were documented with repair or replacement recommendations, and this database may be the new standard for recording and tracking results of follow-on ship assessments for the entire class. With satisfactory completion of all recommended repairs, the structural integrity of the hull will be restored to design specifications. The USCG has already tasked this team to conduct similar inspections on other ships in the Atlantic Fleet.

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Ship Integration & Design

New Ship Design Tools

ASSET and LEAPS Computer Programs Provide Ship Designers with INTEGRATED Design Capabilities

By William Palmer

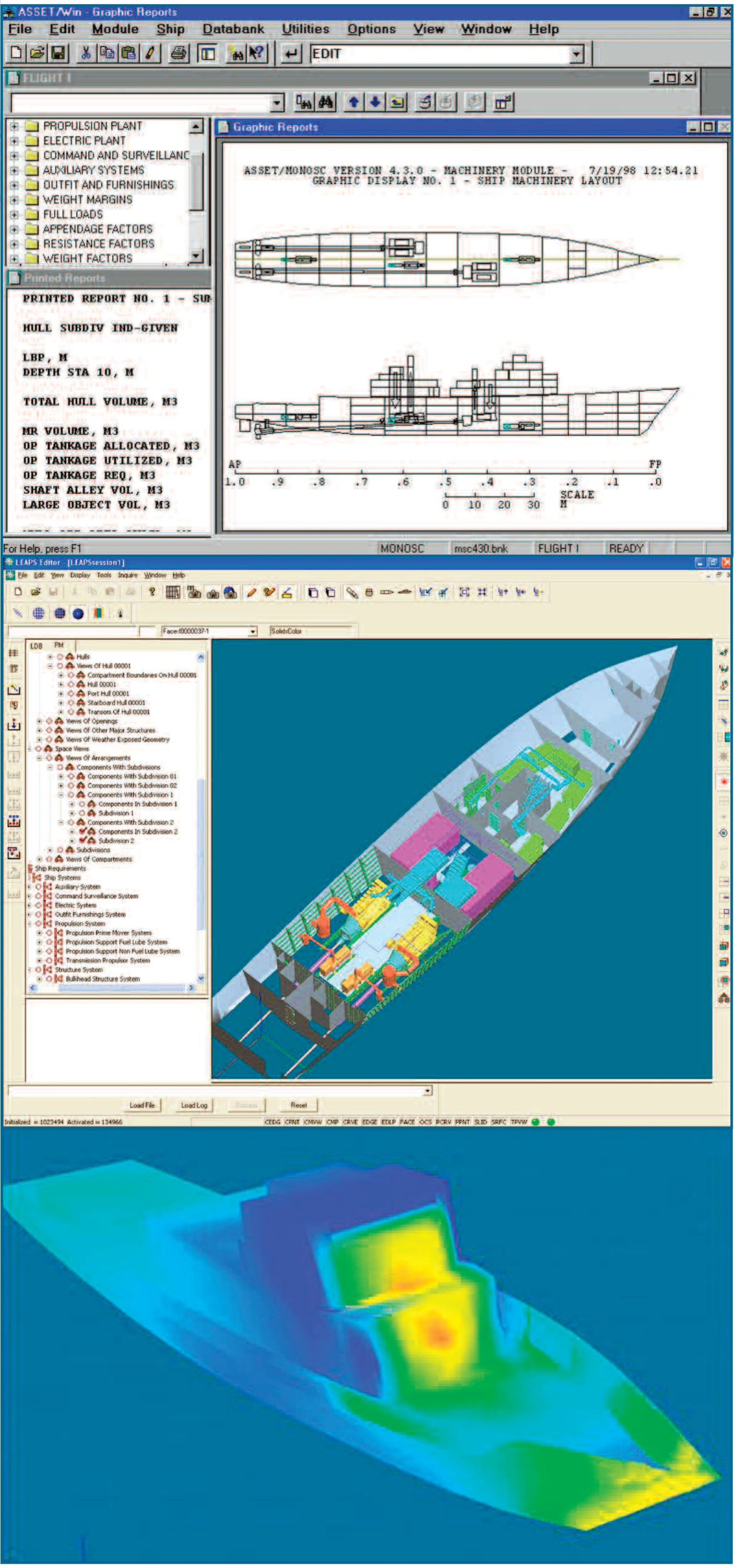
Two computer programs, the Advanced Surface Ship and Submarine Evaluation Tool (ASSET) and the Leading Edge Architecture for Prototyping Systems (LEAPS) are helping naval architects and engineers design ships in more efficient and effective ways. ASSET, which has been developed and supported at the Carderock Division since 1980, is a ship design synthesis model. Ship design synthesis models are used during early-stage design to calculate and balance those ship characteristics that are size and cost drivers. ASSET performs computations across the various naval architectural domains, such as hull form, subdivision, structure, resistance, propulsion machinery, weight, space, and hydrostatics, giving designers the flexibility to change such parameters as size, speed, range, displacement, or payload. Use of ASSET has evolved over time to include use by all Navy and commercial activities involved in early-stage naval surface ship design.

ASSET was initially developed to augment technology assessment, to gain insight into whether or not a new technology will be of benefit in a naval ship design. To support technology assessment, ASSET must be able to address technology characteristics and design configurations before sufficient definition exists to implement algorithms within the program. An infrastructure was built into the program that allows the users to make adjustments to existing algorithms to model new and evolving technologies.

Another major use for ASSET is in support of analysis of alternatives (AOA). New acquisition programs necessitate identification of mission requirements, as well as identification of alternatives in terms of platform types and technologies that can potentially meet these requirements. During an AOA, designs are developed in ASSET for each set of alternatives allowing a cost benefit analysis among the alternatives. At the completion of an AOA, the preferred alternative is selected and more detailed design work can proceed.

New technology can encompass almost any area, such as new materials or electric propulsion, so the level of detail can become quite cumbersome. This is where LEAPS steps in to integrate the analyses and tools of the engineering disciplines within the Ships and Ship

Ship product model data from LEAPS and ASSET.
Images courtesy of Bruce Wintersteen.



Systems (S^3) Product Area. LEAPS is a product modeling environment that provides a mechanism to store the extensive data and relationships representing all parts of a ship and its components. LEAPS provides a common environment where different collections of data about such items as materials, weapons, engines, other components, and design specifications are related through an object model database and made available to users and designers.

LEAPS' development was initiated as an Innovation Cell in 1996, where the project team was challenged to make a "leap" forward in the Carderock Division's modeling and simulation capabilities to integrate the flow of ship design information across the organization. From this starting point, LEAPS' capabilities have been expanded to support the integration and collaboration requirements of major naval ship design programs. Recently, NAVSEA's Ship Design, Engineering, and Integration Directorate (SEA 05) specified that all future design tool development will be required to integrate with LEAPS.

Current ongoing development activities include modifying ASSET to run inside the LEAPS infrastructure, thereby further integrating the early stage design process within ASSET with the range of design and analysis capabilities available from LEAPS. The ASSET-LEAPS Development Team is also working in collaboration with NAVSEA and General Dynamics/Electric Boat to add a submarine design synthesis capability to the ASSET–LEAPS tool set.

ASSET and LEAPS are key tools of the Ship Integration and Design Core Equity supporting the design activities of the S^3 Product Area.

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Hull Forms & Propulsors

Mobile At-Sea Sensor System

Converting a WWII Drydock Section into a State-of-the-Art Sensor Platform to Support Missile Defense Agency Programs

MATSS provides over-the-horizon radar, optics, telemetry, and flight termination support for missile defense test programs.
Photo by Kim Nichols (PMRF).

By William Palmer

A unique team of government and contractor personnel supports the operation of the Mobile At-Sea Sensor System (MATSS) platform. MATSS (IX-524) is a 256-foot-long towed platform providing radar, optics, telemetry, and flight termination support to missile defense testing programs. The MATSS team includes the Pacific Missile Range Facility (PMRF); the Carderock, Dahlgren, and Corona Divisions of the Naval Surface Warfare Center; the Space and Warfare Systems Command; the Naval Air Systems Command; the NAVSEA Inactive Ships Management Office; and contractors Northrop Grumman Xontech, Textron, Integrits, Solipsys, Anteon, Pacific Shipyards International, and ITT Industries. The team uses a Systems Integration Working Group forum of tele-

conferences and meetings to execute MATSS design, development, integration, and testing efforts.

Personnel in the Hull Forms and Propulsors Core Equity of the Ships and Ship Systems (S^3) Product Area (PA) have supported a number of test programs and MATSS platform upgrades in the last six months. The core equity's primary role is to provide hull, mechanical, and electrical engineering, installation and integration of the sensors onto the platform, and at-sea test support for the MATSS platform. During testing events, sensors, and instruments collect optical, radar, and telemetry data and transmit them back in real-time to the PMRF control center over a secure satellite communications link. The PMRF i-Net link connectivity provides pointing data to MATSS and transmits MATSS sensor and telemetry data to sites that are out of line-of-sight view with either the target or intercept missile. Following the test, the data collected by MATSS is used to help evaluate the quality of the intercept and determine if the program's goals have been achieved.

Recent mission support includes Medium Range Target, Critical Measurements and Countermeasures-1, and Flight Mission-7 (FM-7). The FM-7 mission culminated in the fifth successful interception and destruction of a test missile for the Aegis Ballistic Missile Defense program. MATSS is particularly valuable to PMRF and its customer, the Missile Defense Agency (MDA), because of its unique ability to strategically position its sensors in the open ocean during missile testing events. Allowing closer or alternate look angles, MATSS provides important radar and optics data, meteorological data, missile telemetry streams, and flight termination system (FTS) relay capabilities. The success of MDA programs, including FM-7, help to develop the technology and to establish the viability of incorporating an Aegis-based ballistic missile defense into an oceanic protective shield scheme, part of the Sea Basing component of the Navy's transformational *Sea Power 21* initiative. In addition to supporting scheduled missions and required maintenance, the MATSS team has upgraded the platform with the recent installation and integration of a new stabilized high-accuracy optical tracking system; high-altitude meteorological equipment; an S-Band receiver/relay system; and a 7.3-meter diameter telemetry antenna.

The MATSS platform has an interesting history with the Navy. The MATSS hull was formerly one of 10 sections making up a World War II (WWII) Auxiliary Floating Drydock Big (AFDB). Following tow tests, seakeeping tests, analysis, and computer simulations, the AFDB hull was converted into a state-of-the-art sensor platform, taking advantage of its large flat deck, stable seakeeping behavior, and economical towed configuration. MATSS (IX-524) is operated by PMRF in Hawaii and receives a wide range of engineering support from the Carderock Division.

The conversion of a WWII AFDB drydock into a state-of-the-art sensor platform was a unique undertaking that provided the Navy with a necessary capability to support missile defense testing. Four additional AFDB platforms are available for conversion for uses such as at-sea test beds, surveillance platforms, launch platforms, sensor platforms, mobile pierways, helicopter platforms, UAV/AAV platforms, and much more.

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Signatures, Silencing Systems, & Susceptibility

Advanced Electric Ship Demonstrator

Sea Jet *Serves as a Technology Testbed*

By William Palmer

The Advanced Electric Ship Demonstrator (AESD) will execute a series of trials at the Carderock Division's Acoustic Research Detachment (ARD), in Bayview, ID. Recently named *Sea Jet*, this 133-foot-long test platform houses an advanced waterjet propulsion system designed and manufactured by Rolls Royce Naval Marine, Inc. (RRNMI). The RRNMI concept named AWJ-21™ will provide a propulsor system, which will have improved efficiency and will be quieter than a conventional combatant surface ship propeller. Research components of the Ships and Ship Systems (S^3) Product Area will assist ARD personnel in conducting the tests.

Rear Admiral Jay M. Cohen, Chief of Naval Research at the Office of Naval Research (ONR), said in remarks during a christening ceremony, "These tests that are going to be done . . . have direct and immediate implications for the future of our Navy." He also explained that the "plug-and-fight" technology aboard the *Sea Jet* would allow the Navy "to do . . . millions of dollars [in system tests] so we don't waste billions of dollars."

Steve Schreppler, ONR program manager for the project, looked forward to testing at ARD. "Lake Pend Oreille is a very controlled environment," he said. "They're very good at taking high-precision data [and are] craftsmen at doing that sort of thing."

Designers based the AESD on the Type 5565 hullform, an early DD(X) design variant. The platform has a designed displacement of 239,900 pounds and is made of steel. Dakota Creek Industries, Inc. (DCI), in Anacortes, WA, constructed the craft in its shipyard. A diesel generator provides power for the two electric propulsion motors, which are directly shafted to the two waterjet pumps integrated with the hull below the waterline. The 720-cell battery bank powers the motors for acoustic trials, eliminating the diesel engines as a noise source for quiet operations and for high-speed tests. The AESD will be manned with a design complement of six personnel. Due to transformer sizing, the AESD is projected to have a top speed of 8 knots while powered by the diesel generators and 16 knots when using battery power.

The Carderock Division's Large Cavitation Channel (LCC) in Memphis, TN, is the site of hydrodynamic investigations which Dr. Stuart Jessup, program manager for the effort, is coordinating. LCC researchers will use a one-half-scale mockup of the AESD to establish calculations of performance characteristics of the AWJ-21™, verify propulsion characteristics, and assess steering system loads.

> *"These tests that are going to be done . . . have direct and immediate implications for the future of our Navy."*
>
> *—RADM Jay M. Cohen*

An interior view of ***Sea Jet's*** deckhouse.

Photos by John Williams, ONR.

Initial plans called for a 60-foot planing hull for the AWJ-21™ demonstration, but designers chose a displacement hull instead to provide more benefit to the Navy, as the hullform better emulated current Navy surface combatants. ONR plans to conduct research with several modifications to *Sea Jet*, and the AWJ-21™/AESD configuration will undergo testing first.

DCI constructed hull sections of the model, then shipped them to ARD and assembled them at the Model Engineering and Support Facility. This fall, builder's trials will take place at ARD, and acceptance trials will follow, after which the Navy will take control of *Sea Jet*, with testing to continue until March 2006, when another electric-drive propulsion system, called *RimJet*, will be installed on the AESD. The configuration of the *RimJet* design is that of an electric drive propulsion pod mounted via struts below the AESD. The propulsion pod contains an integrated motor/propulsor in which the motor rotor serves as the propulsor, eliminating direct shafting from within *Sea Jet*. During installation of *RimJet*, researchers will remove the old stern section and weld a new section, with *RimJet* hardware installed, in place. Other modifications include removing the deck-house and installing a similar composite-based structure. These trials are slated to start in late FY 06.

ONR provided additional funding to build a high-resolution measurement array to collect data for quiet surface ship noise investigations. The new array system will be verified in the first quarter of FY 06. Also, a joint United States-Netherlands Navy flow noise project is scheduled during the FY 06 testing period. ONR is planning additional technology demonstrations and developing a multi-year plan for technology demonstrations on *Sea Jet*.

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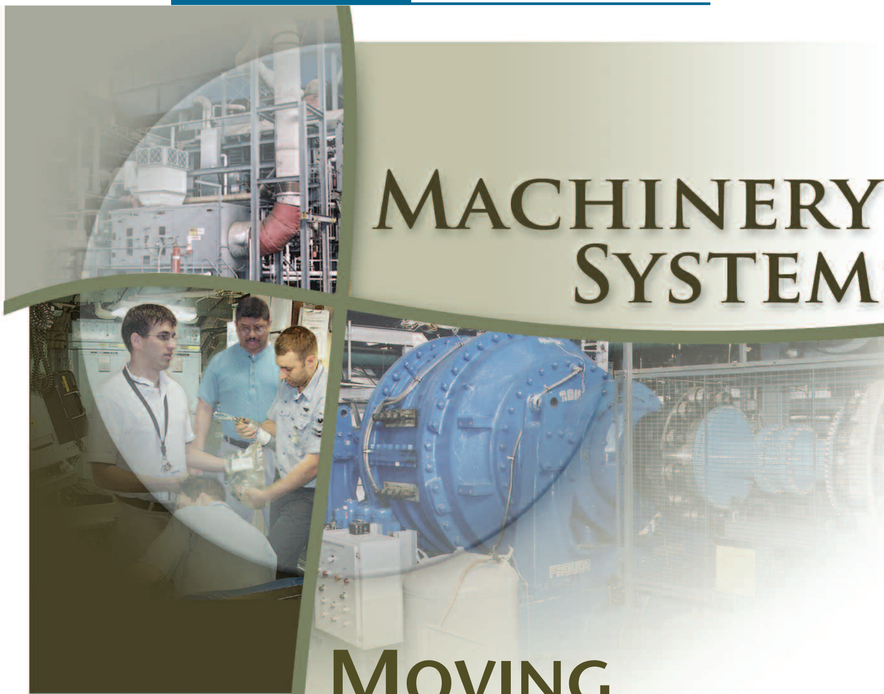

Machinery Systems

Moving Ahead in Distance Support

Collaborative Efforts Lead to Better Shore Support of the Fleet

By Leslie Spaulding

One of the axioms for the U.S. Navy is that we will perform our missions by being the best-trained, best-equipped naval force in the world. We will prevail because of the quality of our personnel and equipment, not by the force of numbers. To do this, our forces must be able to maintain a high degree of readiness because we don't have the luxury of having extra ships and systems to replace those that don't work when they are needed. Distance Support is one of the primary ways we ensure that our forces are ready when they are needed.

Before retiring as Commander, Naval Sea Systems Command, Vice Admiral Phillip M. Balisle wrote, "Distance support is a philosophy, a concept for doing business, and an actual capability. It will be the foundation upon which our 21st Century Navy will operate. It will touch every one of us."

A technical representative captures data and provides it to systems engineers via Distance Support.
Photo provided by John Whipple (NAVSEA).

Since 1999, the Naval Sea Systems Command, the Naval Supply Systems Command, the Space and Naval Warfare Systems Command, and the Fleet Commanders have operated under a collaborative agreement providing real-time technical assistance to afloat Navy units. Initially, this support focused on providing the warfighter with assistance in resolving technical, logistics, maintenance, and quality of life issues through a single, shorebased coordination point/customer advocate. With that phase successful, Navy leadership is now looking toward making dramatic changes to the shore infrastructure and using Distance Support to enable those changes. To guide these collaborative efforts and coordinate with fleet needs and objectives, the Distance Support Governance Board was established.

Duane Embree, the Product Area Director for Surface Warfare Logistics and Maintenance, is responsible for the Distance Support process. This process provides answers to technical questions, solutions to logistics problems, solutions to supply issues, answers to systemic problems, improved equipment operability and maintainability, and enhanced quality of service. Its objectives are to decrease workload, reduce maintenance costs aboard ships and within maintenance and supply organizations, increase readiness of ships, and improve quality of shipboard life.

The Ships and Ship Systems (S^3) Product Area (PA) provides the technical facilities and expertise needed to respond quickly and effectively to resolve fleet problems involving the platforms and associated systems under the

A Sailor uses a PDA to gather configuration data to provide back to shore via Distance Support.
Photo provided by John Whipple (NAVSEA).

Sailors use "Sailor-to-Engineer" portal and Distance Support to resolve shipboard problems.
Photos provided by John Whipple (NAVSEA).

cognizance of the S^3 PA. This product area has been integrally involved with Distance Support since its inception, providing maintenance and logistical support based upon information gathered through experimentation with the Integrated Condition Assessment System (ICAS) and Technical Data Knowledge Management-Integrated Data Environment (TDKM-IDE). The S^3 in-service engineers support the fleet from their desktops via both secure and unclassified communications networks.

"In the past it was common for technical support personnel to be flown around the world to assist a fleet asset in need," said Thomas Perotti, the Distance Support and Integrated Networks Lead for the S^3 PA. "Logistics information was distributed in a cumbersome paper format, which took a long time to produce and was expensive to reproduce, send to, and store aboard ship. Machinery assessment data were downloaded and transferred off of a platform after a deployment instead of while underway, limiting the ability to perform near real-time diagnostics or prognostics of problematic hardware and software onboard ship."

Distance Support is changing all that. The road ahead, in terms of life-cycle management and in-service engineering, provides for an evolution in these services. For example, the TDKM-IDE is a prototype system to deliver configuration-managed technical data to fleet users anywhere in the world. Unlike the current system, which requires volumes of CD-ROMs to be distributed to the ships, the TDKM-IDE will provide online access to all technical data required for personal development. Another example is ICAS, which captures data from the ship and is used for shipboard maintenance, technical support, and condition assessment of machinery systems. In the past, the ICAS data would be emailed to shore as needed or downloaded when the ship returned to port. Recent Distance Support experimentation demonstrated ICAS Remote Maintenance Monitoring Process provides information to shore-side subject matter experts without visiting the ship, thus providing reach-back capability while performing automated/remote assessments. Said Perotti, "Through integrating ICAS with Distance Support, it's possible to more readily share machinery condition assessment information with the shore support facilities and Fleet Regional Maintenance Centers." There is a movement to expand the capabilities of this type of system to include combat systems, as well as machinery systems, to ensure the total ship is supported.

"These new methods of deploying and sharing ship-based technical and logistics information will be the future of how we communicate with the fleet from shore with many of our in-service engineering agent products and services," said Perotti. "Distance Support is crucial to the Navy After Next. Navy leadership wants fewer Sailors on the ships and more robust systems that require less maintenance. Only through Distance Support can we accomplish this."

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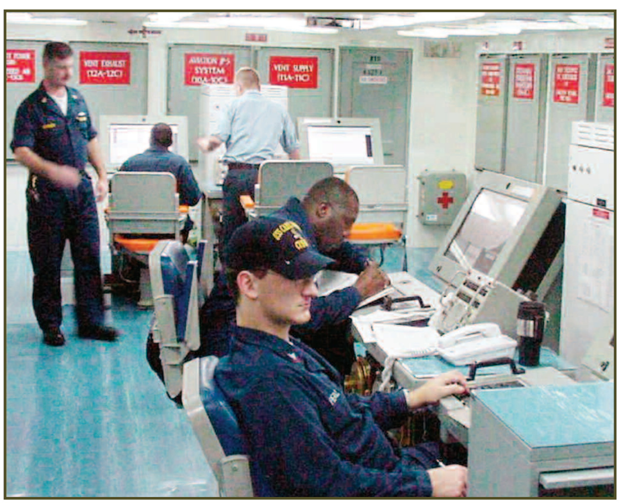
MACHINERY CONTROL SYSTEM

Setting the Pace for the Navy

By Leslie Spaulding

Anyone with a personal computer knows that fighting obsolescence is an uphill battle—as soon as an upgrade is installed, there's a new one on the horizon. This certainly holds true in the fleet, where information technology and networks are helping to reduce manning by automating everything from log-taking to engine start-up.

The Machinery Control System (MCS) in today's fleet runs the gamut of technology. The MCS is used to control and monitor shipboard machinery systems, such as the propulsion plant, electric plant, auxiliaries, and damage control systems. In the 1970s, the MCS combined manual operation with compartmentalized hard-wired remote electronic panels and consoles built to military specifications. In the 1980s, the MCS moved to a software-based configuration, with one computer program language and an embedded operating system. Most of the control was achieved by using pushbuttons, indicators, and meters. The plant signals were hard-wired to the console. In the 1990s, distributed control was introduced, featuring distributed input/output (I/O) racks and user interface, multiple processors, commercial software, and the ability to have other applications running on the consoles. There were no physical pushbuttons or meters. The distributed systems use different computer program languages and operating systems.



Smart Carrier machinery control system operators work in Damage Control Central on a *Nimitz* Class carrier.
Photo by Jeff Cohen.

This distributed configuration continues today but has been made smarter. With multiple processors and embedded equipment software, today's MCS uses more computer program languages, operating systems, and applications. It features device level networks and extremely flexible open architecture and provides decision aids, auto-recovery, and onboard engineering training systems. Unlike the old systems on which a Sailor could operate and control only one system from an assigned, hard-wired MCS, the distributed networks of today allow Sailors to view, operate, and control any plant function from any console connected to the network.

While the old architecture presents obvious issues, such as maintenance, the new systems are not without their challenges. Multiple software programs are running on one network and using the same data, so proper integration is paramount. Although the current MCS is much more reliable and maintenance free, it is also much more complex—requiring a different skill set from the Sailor. Today's system offers an onboard training capability—on which the Sailor can train against a simulation of the plant at sea. This provides much more in-depth, realistic training without actually operating the plant. It promises to make the crews more effective faster.

Another benefit provided by the new distributed MCS is increased survivability because Sailors can operate all systems from all consoles. So if one workstation goes down the ship can still function by controlling the machinery system from another location. Additionally, having the MCS networked enhances the ability for distance support. By interfacing with the ship's Integrated Condition Assessment System (ICAS), the MCS has access to more diagnostic data. The Smart Carrier is a good example of this (see box on page 17).

Currently, engineers from Carderock Division supporting the Ships and Ship Systems (S^3) Product Area are involved in the Navy's latest Machinery Control and Monitoring System (MCMS) modernization program. This program focuses on improving the system's reliability, while reducing workload.

The Smart Carrier MCMS has been installed on the CVN 72 and 73, and installation on CVN 74 is underway. In the summer of 2006, installation will take place on CVN 75. CVN 71 will receive the backfit the following year. Additionally, aspects of it will be installed on CVN 70 during its Reliability Centered Overhaul.

The Smart Carrier backfits took lessons learned from the evolution of previous architectures and configurations, such as the Distributed Data and Control Networks (DDCN), then applied those lessons to the Smart Carrier design. As a result, the Smart Carrier installations and operations on both CVN 72 and CVN 73 were very successful, requiring little follow-up. Based upon this success, future implementation of Smart Carrier system attributes will be implemented in the design and modification of existing and future DDCN systems on other CVNs. The DDCN includes List Control, JP-5, AC Plant Remote Monitoring, AFFF, and a core network. The engineers have developed roadmaps that describe the desired future DDCN baseline architecture, address obsolescence, and are used to plan and schedule system improvements.

Each ship class has its own modernization program, looking at replacing the existing systems with more distributed control systems. Lessons learned from these modernization efforts are being applied to the development of a new MCMS for the CVN 21 Class. With reduced manning requirements, the CVN 21 requires a detailed analysis of the level of control and automation necessary for each ship system. The use of distributed digital control systems continues to expand. These systems provide a significant improvement in operational capability, and those in the design phase promise to narrow the gap between today's Navy and the Navy after Next.

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FRICTION STIR WELDING

Engineers Explore a Promising New Technique for Joining Metals

By William Palmer

A new way of joining metal to create a very strong bond and improved properties is being investigated. This new technology is friction stir welding or processing (FSW or FSP). Some of its most fascinating features are that it does not melt the metal, there is no electric arc or additional filler metal, and the motion of the welding implement is controlled digitally. This technology, invented and patented by The Welding Institute in England in 1991, is a solid-state joining process that uses a rotating pin tool to soften and

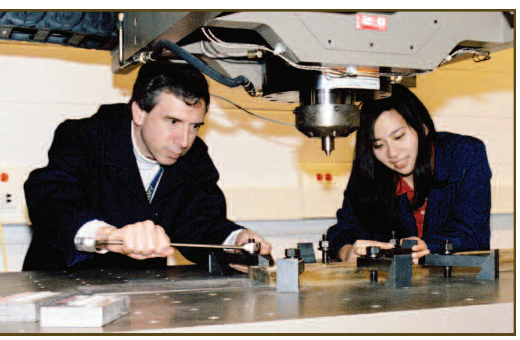
FRICTION STIR WELDING (Continued on page 18)

FRICTION STIR WELDING (Continued from page 17)

mix the metal, much like cookie dough in a mixer, to locally change the characteristics and properties of a material by the hot-stirring nature of the process.

The technique uses a numerically controlled machine to precisely position a rotating "stirring" device, or pin tool, over the weld joint or area of interest. The machine lowers the tool until it makes contact with the metal and then turns the tool at high rotational speeds. It can apply up to 30,000 pounds of downward hydraulic pressure to the tool. Under this pressure, the tool burrows into the metal, softening it with heat from the friction of contact. This process has an added benefit that the melting temperature of the metal, and thus a liquid state, is never achieved. A software program, controlling the depth to which the tool goes into the metal and the translation speed, moves the pin tool forward at several inches per minute until the run is completed. The machine can be programmed to follow flat and curved surfaces, as well as any raster pattern on the surface.

The pin tool can be of various shapes and sizes. These shapes can be as simple as a plain cylindrical or conical shape, can be shaped like a very blunt screw with extremely coarse threads, or have very intricate designs such as triflutes, steps, and/or scrolled shoulders. The design of the pin and shoulder assembly plays a major role on how the material moves during the process. In addition, the FSW system has the capability for adjustable-pin or self-reacting weld and processing. The adjustable pin is ideal for use on beveled surfaces or to eliminate the exit hole at the end of a pass. The self-reacting tool allows welding/processing the entire through-thickness volume under the shoulder from both sides of the work piece.



Dr. David Forrest and Jennifer Nguyen tighten hold-down brackets on friction stir welding machine bed. The pin tool is between them.
Photo by Pam Lama.

A number of factors affect the weld quality. Such parameters as the type of metal, the angle of the tool, how fast the pin tool is moving, how fast it's spinning, how much pressure is applied by the pin tool all come into play when using the FSW process. In some applications where a threaded pin is used, the material being welded can collect on the threads of the pin tool, necessitating cleaning the threads to remove the excess material, so the pin tool can be used again. Does the process create a lot of noise? No, it is surprisingly quiet. The most audible noise is generated by hydraulic pumps, which are used to move the pin tool mounting mechanism.

The Navy is interested in extending this technology to shipbuilding because the process is more environmentally friendly and safe and produces less distortion than conventional welds. These benefits significantly lower costs associated with engineering controls currently in place for fume mitigation and distortion control. While friction stir welding was originally developed for aluminum where it has enjoyed great success, such as in the construction of the space shuttle external fuel tanks, its transition to steel is challenged by tool wear and productivity obstacles.

The Office of Naval Research (ONR) has supported efforts in FSW that have demonstrated the feasibility of joining higher strength materials such as steels with FSW. ONR continues to support efforts in advanced equipment development, tool design and tool material development, welding process optimization, and understanding and predicting microstructural and mechanical property evolution during joining through physical simulations and modeling.

The ultimate goal of both ONR and engineers in the Structures and Materials Core Equity in support of the Ships and Ship Systems (S^3) Product Area is to extend the technology to a wide range of materials and thicknesses of interest to the Navy, including aluminum, titanium, stainless steels, and potentially dissimilar alloys and composites. There is currently an effort to develop a welding envelope for HSLA-65 steels, aided by physical and mathematical modeling and followed by experimental validation. In addition to FSW of HSLA-65, there are efforts to further develop and validate a 3-D finite element FSW model using 304L stainless steel material parameters, as well as other work performed in metal matrix composites, AL-6XN, and titanium.

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Environmental Quality Systems

Cleaner, Easier, Better

Improving the Fleet's Ability to Process Plastic, Reducing Waste and Manpower

By Paul Schwegler and Leslie Spaulding

The fleet uses the Plastics Waste Processor (PWP) to process shipboard generated plastic waste into dense (less than 1/30 the volume), sanitary disks suitable for long-term storage. These processors allow ships to store their plastic waste while at sea in compliance with zero-plastic waste discharge restrictions. Under what is now the Environmental Quality Core Equity for the Ships and Ship Systems (S^3) Product Area (PA), the development of the plastics processing technology started in 1993. By the end of 1998, the Navy installed more than 600 processors. However, fleet operations show that the current PWPs require excessive manhours to operate and have high corrective and preventative maintenance costs.

To reduce operational and maintenance manhours associated with the equipment, the PWPs were upgraded to a modified version (MOD 1 PWP). The MOD 1 PWP has 34% fewer components and a process time that is 15 minutes less than the original design with a 300% increase in process rate. Under improvements made, a single pneumatic actuator replaced the electro-mechanical drive system for compression. S^3 engineers simplified the temperature control system by replacing the resistance temperature detectors with thermostatic switches and removing two modules from the controller.

New compressed melt units were installed aboard *USS Tarawa* (LHA 1) through a machinery alteration. *Photo by Paul Schwegler.*

Additionally, chamber heaters and associated contactors were removed. The redesigned lower frame of the unit now allows easier access for cleaning. The modified unit also incorporates nine self-cleaning nozzles that are connected to the ship's hot potable water service. The new direct cooling system used with the auxiliary unit does not need a pump or a heat exchanger and has a total of 84% fewer parts than the current closed-loop

CLEANER, EASIER, BETTER (Continued on page 20)

CLEANER, EASIER, BETTER (Continued from page 19)

cooling unit. The direct cooling system utilized by the auxiliary unit also cools the compress melt unit in about half the time of the original system.

The Navy installed the new MOD 1 PWPs aboard *USS Nassau* (LHA 4), *USS Milius* (DDG 69), and *USS Harry S. Truman* (CVN 75). So far, the processing rate of plastic waste increased more than 300% over the legacy machine; maintenance and operational manning was reduced by 50%; reliability increased by about 50%; and cleaning decreased by 60%. The number of maintenance requirement cards decreased from nine to two cards. In fall 2002, the modified processor underwent testing onboard these ships throughout a six-month deployment. Shipboard evaluation ended in the fourth quarter of FY 03, and the units are still operating on these platforms today. These results led to a teaming between the S^3 Product Area's Environmental Quality and Machinery Systems Core Equities. Collectively, they developed a machinery alteration for all surface ships and a ship alteration for CV and CVN Classes. Currently, with 21 ships complete, the Navy estimates the remaining 102 installations will conclude in approximately six years.

The new MOD 1 PWP equipment is also being supplied to several new ship construction programs for forward-fit application. The LHD 8, CVN 77, LHA(R), LPD 17 Class, LCS, and DD(X) programs are just a few of the platforms scheduled to use the MOD 1 PWP equipment for new construction.

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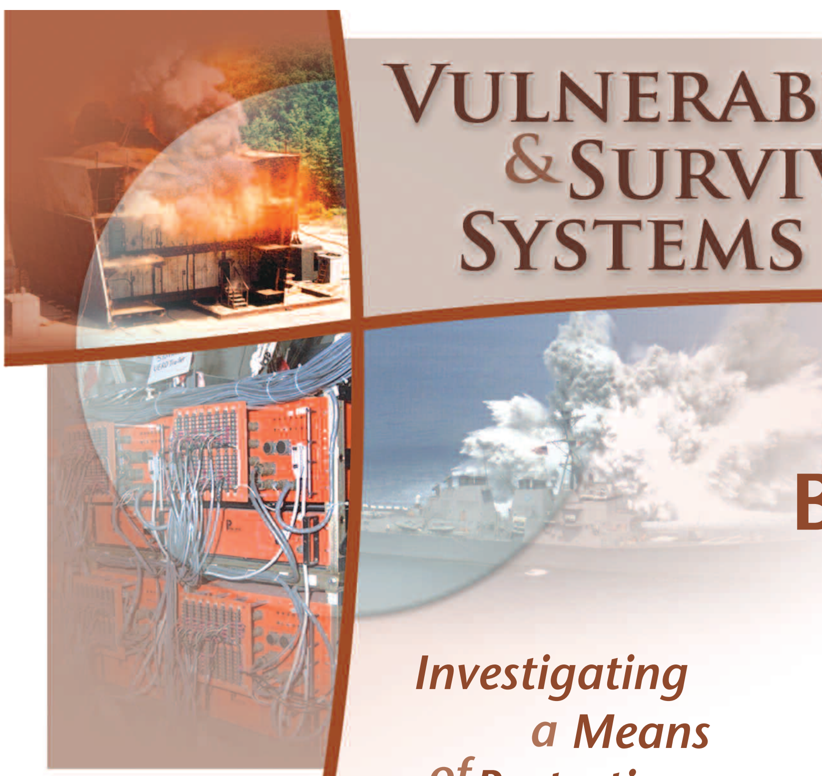


VULNERABILITY & SURVIVABILITY SYSTEMS

CELLULAR-BASED BLAST MODULES

Investigating a Means of Protecting Shipping Against Blast Energy

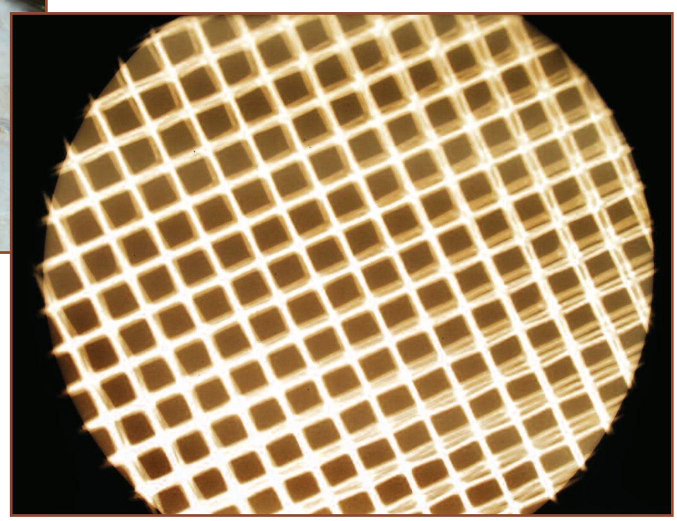
By William Palmer

The Carderock Division and the University of Virginia (UVA) are investigating cells constructed of steel in various core geometries to assess their ability to sustain quasi-static loads and absorb dynamic energy. If the cells successfully withstand the forces to which they are exposed during testing,

This multi-layered pyramidal specimen was dynamically tested using the Dynocrusher.
Photo by Yungchia Chen.

Dave Knight assembles the Dynocrusher waterborne test rig. The water tank above the frame holds an explosive charge to dynamically test cells.
Photo by Yungchia Chen.

Radiograph of a multi-layered pyramidal prior to testing (top view).
Photo by Alan Cohn.



they may be used in structural configurations to provide protection for Navy ships. The Office of Naval Research's (ONR's) "Swamp Works," a special research office, is investing three years in the research effort.

UVA is building the test articles, while Navy engineers in the Vulnerability and Survivability Core Equity of the Ships and Ship Systems (S^3) Product Area (PA) evaluate them using a large 600,000-psi capacity highly controllable test machine and a one-of-a-kind measuring device called the "Dynocrusher." This device was designed and fabricated to measure transmitted loads, according to Yungchia Chen, a principal Navy researcher on the project.

To test the cells in a dynamic environment, the Dynocrusher uses water to transfer the energy of an explosion to cellular specimens. A small explosive charge detonates 4 and 10 inches above the cellular specimen. A special high-rate transducer measures energy dissipation from core crushing. More crushing of a core means that less energy reaches the transducer.

The cellular cores are fabricated of steel and brazed to two faceplates using a high-temperature process. The cellular core crushes either under quasi-static or explosive loads. Some of the cellular designs investigated are diamond prismatic, regular prismatic, multi-layered

MODULES (Continued on page 22)

TECHNOLOGY & INNOVATION

MODULES (Continued from page 21)

pyramidal, and triangular and square honeycomb. When exposed to impulse events such as an explosion or other dynamic loads, optimum designs would absorb the energy through core crushing. Researchers are currently determining which shape and core geometry is the most efficient for dispersal of the energy. All the cells have a core density of 5%, which means the cells are only 5% solid, with the remaining 95% being taken up by an air volume.

The cells also undergo quasi-static testing using the Dynocrusher. This machine applies a load to the cellular cores at a controlled rate of 0.1 inch per minute until the cores fail. Researchers found interesting differences among failure patterns seen in the Dynocrusher. ABAQUS, a computer simulation program, closely predicted the shape some cells would take in quasi-static tests.

A full range of cells were tested, and a team of researchers from the S^3 PA, private industry (ATR Corporation), ONR, Bath Iron Works, and the University of Virginia and its affiliate, CMI Corporation, selected promising designs for testing on larger scales.

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Sea-Based Transfers of Personnel and Cargo

Innovation Center Project Identifies System Concepts to Achieve Sea-Based Ship-to-Ship Transfers

By Andy Anderson and William Palmer

In late April 2005, a design team, under the auspices of the Carderock Division's Innovation Center, completed a study to develop alternative system concepts for transferring personnel and cargo between ships at a Sea Base up through Sea State 4. The project, known as Sea-Based Transfers of Personnel and Cargo (STO-PAC), began in October 2004 and completed in May 2005. If efforts to secure funding to continue the work begun by the project are successful, the Ships and Ship Systems (S^3) Product Area will lend its support in terms of work assignments and expertise in bringing the project to reality.

The STO-PAC team tackled one of the hardest problems presently facing the Sea Base concept. Ship-to-ship/ship-to-craft equipment, material and personnel transfer is, arguably, one of the most significant and technically challenging aspects of the Sea Base effort.

The design team adopted a "shared leadership" functional model and consisted of three full-time members, three part-time members, and two off-site personnel—one from NSWC Combatant Craft in Norfolk and the other from NSWC Panama City. One of the early

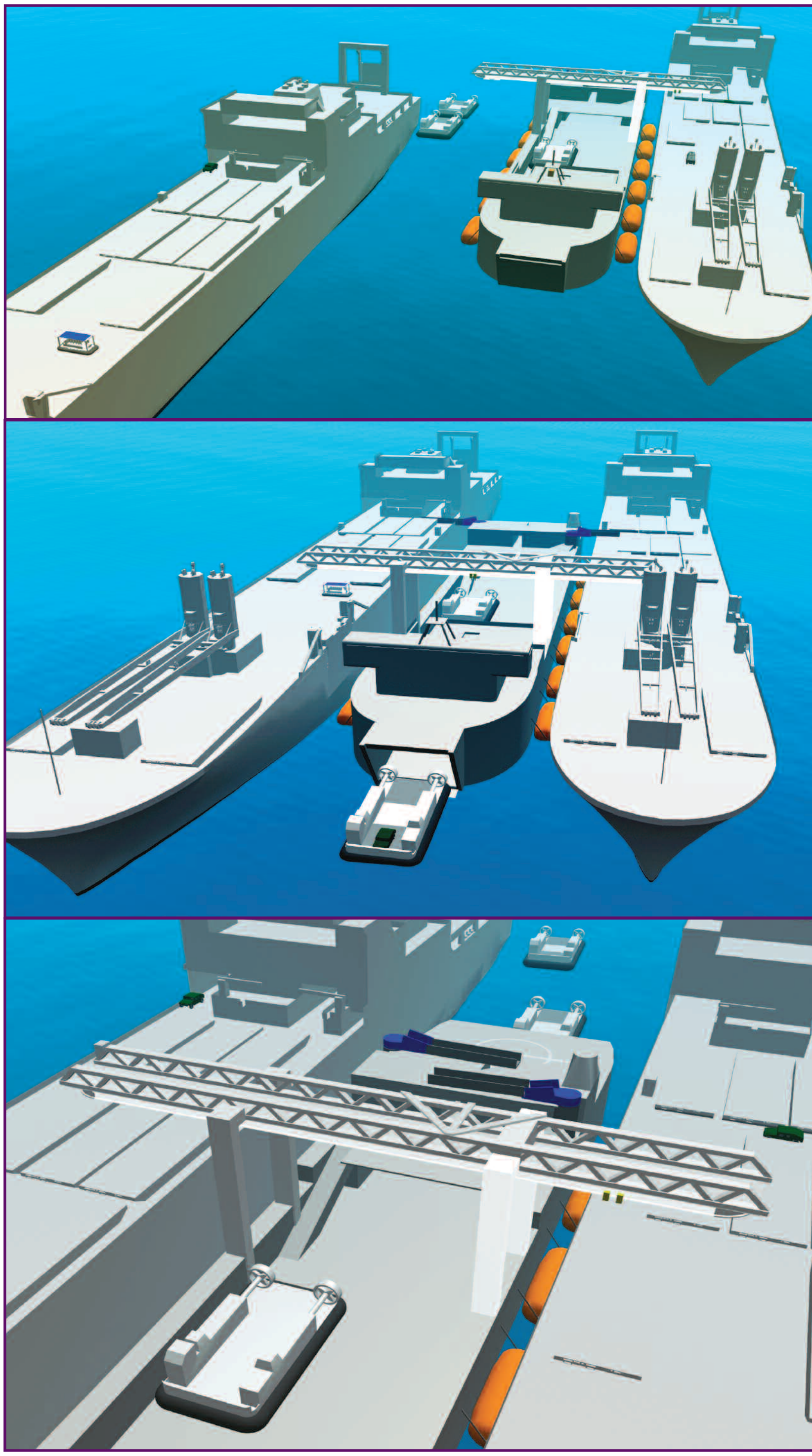
findings of the team was that there was not a single solution that could solve all the problems. Instead, a system of systems had to be developed to cover all contingencies. While investigating the transfer relationships, the team developed the "STO-PAC Design Triangle."

This framework shows the compromising nature of the problem by identifying how throughput, safety, and availability must be traded off against each other.

In an effort to understand the overarching problems, the team created the STO-PAC Concept of Operations (ConOps). One purpose of the ConOps was to identify existing technologies and processes that facilitate Sea Base transfer-at-sea operations, e.g., the Office of Naval Research's (ONR's) High-Capacity Alongside Sea-Base Sustainment (HiCASS) system. The ConOps tool identified the Employ Phase, in which Marines are deployed during cover of darkness, as the most difficult portion of the entire Sea Base concept to achieve with current technology and processes. The team deduced that parallel flow paths between ships were the key to ensuring the necessary throughput, while not sacrificing availability or safety.

A new type of ship, called the *Sea Beast*, and the accompanying process for using the ship, called the Connector Sandwich, were developed as solutions for this problem. The *Sea Beast* is both a ship design as well as a collection of individual technologies working together to enable the transfer of personnel and cargo at the Sea Base. When operating in the Connector Sandwich mode, it takes up position between two Maritime Preposition Force (MPF) ships and enables the transfer of personnel, cargo, and vehicles from the MPF vessels onto the *Sea Beast*. These items are then continually loaded onto the Landing Craft Air Cushions (LCACs), based on the *Sea Beast*, and launched to their objective. When the LCACs

SEA-BASED TRANSFERS (Continued on page 24)



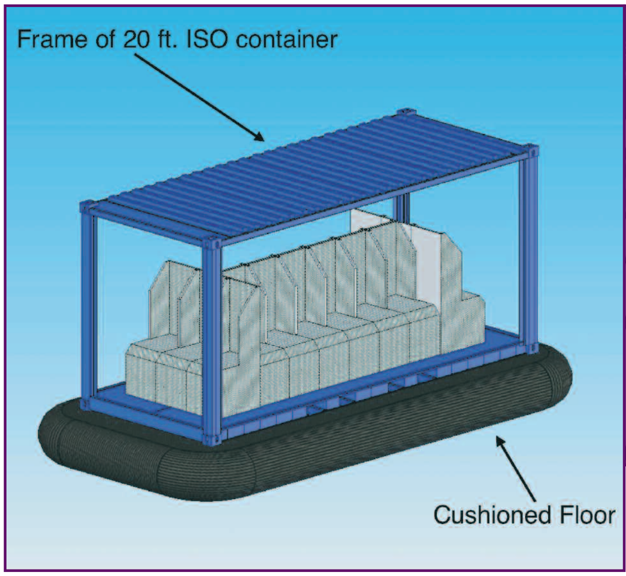
Animation images illustrating the "Connector Sandwich" process and the closed-loop, rail-mounted gantry crane, as the ***Sea Beast*** docks with conventional cargo ships, launching LCACs.
Images courtesy of Carderock Division Innovation Center.

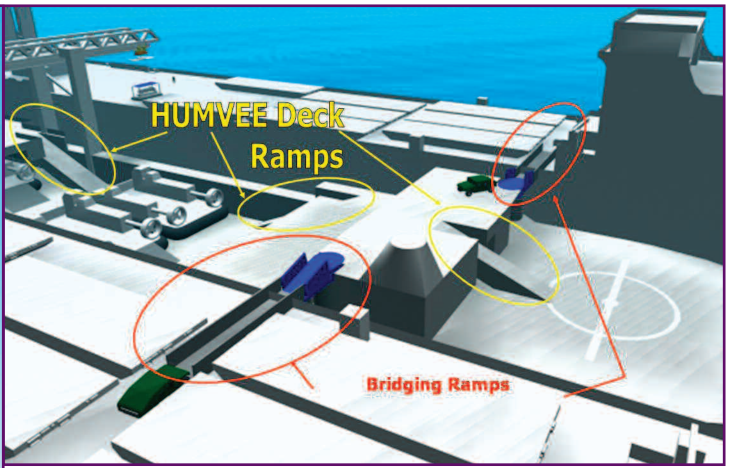
TECHNOLOGY & INNOVATION

SEA-BASED TRANSFERS (Continued from page 23)

return after delivering their cargo to shore, the process is repeated. The *Sea Beast* does not depend upon elevators or ballast-down capability to accommodate the LCACs—they can actually drive on and off the *Sea Beast* via a shallow bow and stern ramp.

In addition to the work in developing *Sea Beast*, the STO-PAC team also created new systems that will work both on and off the *Sea Beast* platform. These systems include a closed-loop, rail-mounted gantry crane and four carriages, which can be independent or linked





Left, Gator Crate. Above, Ramps for HUMVEE RO/RO.
Images courtesy of Carderock Division Innovation Center.

together, a personnel transfer system based on a 20-foot ISO (International Standards Organization) shipping container called "Gator Crate," and the "Universal HUMVEE Bridging Ramp," used as a means to allow roll-on/roll-off traffic between adjacent ships at differing deck levels at sea. While each of these three concepts will benefit the *Sea Beast*, they also have value for other ships.

One of the truly novel outcomes of the STO-PAC work is the application of traditionally land-based seismic dampers to marine usage. Based upon early calculations, the marinization of these vertical mechanical connections radically reduces the relative vertical motions between ships moored together at sea.

Members of the team are pursuing follow-on work with the expectation that work on subsystem technology concepts might begin in FY 06.

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Ship Integration & Design

This core equity applies specialized expertise for surface and undersea vehicle design including early concept development, assessment and selection of emerging technologies, integration of selected technologies into optimized total vehicle designs, and evaluation of those technologies and designs for cost, producibility, supportability, and military effectiveness.

Machinery Systems

This core equity provides full-spectrum technical capabilities (facilities and expertise) for research, development, design, shipboard and land-based test and evaluation, acquisition support, in-service engineering, fleet engineering, integrated logistic support and concepts, and overall life-cycle engineering.

Hull Forms & Propulsors

This core equity provides the Navy with full-spectrum hydrodynamic capabilities (facilities and expertise) for research, development, design, analysis, testing, evaluation, acquisition support, and in-service engineering in the area of hull forms and propulsors for the U.S. Navy.

Vulnerability & Survivability Systems

This core equity provides full-spectrum capabilities (facilities and expertise) for research, development, design, testing, acquisition support, and in-service engineering to reduce vulnerability and improve survivability of naval platforms and personnel.

Environmental Quality Systems

This core equity provides facilities and expertise for research, development, design, human systems integration, acquisition support, in-service engineering, fleet support, integrated logistic concepts, and life-cycle management resulting in mission compatible, efficient and cost-effective environmental materials, processes, and systems for fleet and shore activities.

Signatures, Silencing Systems, & Susceptibility

This core equity specializes in research, development, design, testing, acquisition support, fleet guidance and training, and in-service engineering for signatures on ships and ship systems for all current and future Navy ships and seaborne vehicles and their component systems and assigned personnel.

Structures & Materials

This core equity provides the Navy with specialized facilities and expertise for the full spectrum of research, development, design, testing, acquisition support, and in-service engineering in the area of materials and structures.

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